

WHAT IS CLAIMED IS:

- 1           1. A system for forming a cardiac muscle construct, comprising:  
2           a substrate; and  
3           cardiac cells provided on the substrate in the absence of a scaffold,  
4           the cardiac cells cultured *in vitro* under conditions to allow the cells to become  
5           confluent and detach from the substrate to form a three-dimensional cardiac muscle  
6           construct.
- 1           2. The system according to claim 1, wherein the cardiac cells self-  
2           organize to form the three-dimensional cardiac muscle construct.
- 1           3. The system according to claim 1, wherein the cardiac cells include  
2           cardiac myocytes.
- 1           4. The system according to claim 1, wherein the cardiac cells include  
2           fibroblasts.
- 1           5. The system according to claim 1, wherein the cardiac muscle  
2           construct is spontaneously contractile.
- 1           6. The system according to claim 1, wherein the cardiac muscle  
2           construct is responsive to electrical stimuli.
- 1           7. The system according to claim 1, wherein the cardiac muscle  
2           construct is responsive to chemical stimuli.
- 1           8. The system according to claim 1, wherein the cardiac muscle  
2           construct is resistant to fatigue.
- 1           9. The system according to claim 1, further comprising at least two  
2           anchors secured to the substrate in spaced relationship with at least some of the  
          cardiac cells in contact with and attachable to the anchors.

1           10. The system according to claim 9, wherein the anchors include  
2 silk suture segments coated with cell adhesion molecules.

1           11. The system according to claim 10, wherein the cell adhesion  
2 molecules include laminin.

1           12. The system according to claim 1, wherein the substrate is coated  
2 with cell adhesion molecules.

1           13. The system according to claim 12, wherein the cell adhesion  
2 molecules include laminin.

1           14. The system according to claim 13, wherein the concentration of  
2 laminin is about 0.4 to 2.0  $\mu\text{g}/\text{cm}^2$ .

3           15. The system according to claim 1, wherein the cardiac muscle  
4 construct is substantially cylindrical.

1           16. The system according to claim 1, further comprising skeletal  
2 muscle cells cultured in combination with the cardiac cells.

1           17. A method for forming a cardiac muscle construct, comprising:  
2           providing a scaffold-free substrate;  
3           providing cardiac cells on the substrate; and  
4           culturing the cardiac cells *in vitro* under conditions to allow the cells  
5 to become confluent and detach from the substrate to form a three-dimensional  
6 cardiac muscle construct.

1           18. The method according to claim 17, wherein providing cardiac  
2 cells includes providing cardiac myocytes.

1           19. The method according to claim 17, wherein providing cardiac  
cells includes providing fibroblasts.

1                   20. The method according to claim 17, further comprising eliciting  
2 a response of the cardiac muscle construct to electrical stimuli.

1                   21. The system according to claim 17, further comprising eliciting  
2 a response of the cardiac muscle construct to chemical stimuli.

1                   22. The method according to claim 17, further comprising securing  
2 at least two anchors to the substrate in spaced relationship with at least some of the  
3 cardiac cells in contact with the and attachable to the anchors.

1                   23. The method according to claim 22, wherein the anchors include  
2 silk suture segments coated with cell adhesion molecules.

1                   24. The method according to claim 23, wherein the cell adhesion  
2 molecules include laminin.

1                   25. The method according to claim 17, further comprising coating  
2 the substrate with cell adhesion molecules.

1                   26. The method according to claim 25, wherein the cell adhesion  
2 molecules include laminin.

1                   27. The method according to claim 26, wherein the concentration of  
2 laminin is about 0.4 to 2.0  $\mu\text{g}/\text{cm}^2$ .

1                   28. The method according to claim 17, further comprising measuring  
2 a functional property of the cardiac muscle construct and using the measured  
3 property as feedback to control the formation of the cardiac muscle construct.

1                   29. The method according to claim 17, further comprising culturing  
2 skeletal muscle cells in combination with the cardiac cells.

1                   30. The method according to claim 17, further including implanting  
2                   the cardiac muscle construct in a suitable recipient.

1                   31. The method according to claim 17, further including wrapping  
2                   an acellularized aorta with a layer of cardiac cells.

1                   32. A cardiac muscle construct, comprising:  
2                   cardiac myocytes provided on a scaffold-free substrate, the cardiac  
3                   myocytes cultured *in vitro* under conditions to allow the myocytes to self-organize  
4                   and become a confluent monolayer, the monolayer detaching from the substrate to  
5                   form a three-dimensional cardiac muscle construct.

1                   33. The cardiac muscle construct according to claim 32, further  
2                   comprising fibroblasts provided in combination with the cardiac myocytes.

1                   34. The cardiac muscle construct according to claim 32, wherein the  
2                   construct is spontaneously contractile.

1                   35. The cardiac muscle construct according to claim 32, wherein the  
2                   construct is responsive to electrical stimuli.

1                   36. The cardiac muscle construct according to claim 32, wherein the  
2                   construct is responsive to chemical stimuli.

1                   37. The cardiac muscle construct according to claim 32, wherein the  
2                   construct is resistant to fatigue.

1                   38. The cardiac muscle construct according to claim 32, wherein the  
2                   construct includes adherens junctions formed between the cardiac myocytes.

1                   39. The cardiac muscle construct according to claim 32, wherein the  
2                   construct includes gap junctions between the cardiac myocytes.

- 1                  40. The cardiac muscle construct according to claim 32, wherein the
- 2        cardiac muscle construct is substantially cylindrical.